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(54) Protocol converter and router for multi-mode wireless data communications

(57) The present invention encompasses an apparatus and method for supporting multiple wireless data communication networks (107) between a wireless communications device (108) and a fixed communications device (101) or another wireless communications device. Two network elements compose the physical apparatus, a protocol converter (300) and a router (104). Upon receiving packet data from a fixed communications device, a router will locate a destination wireless communications device. The router will then convert the packet data to a format usable by the wireless data network that the wireless communications device is currently using for wireless access. After conversion, the router will perform actual transmission of the packet data to the correct destination wireless network. Once the converted packet data is received by the wireless network base station, it will be transmitted via RF to the destination wireless communications device. The router will also perform reverse functions of receiving packet data from a wireless communications device across wireless data network and then perform necessary conversion to a format usable by fixed communications device. The router will then perform actual transmission of the converted packet data to the fixed communications device.

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EUROPEAN SEARCH REPORT

Application Number
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DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	WO 95 17077 A (SAINTON JOSEPH B) 22 June 1995 (1995-06-22)	1,4	H04L12/28 H04L12/46
A	* page 10, line 1 - page 12, line 6 * * page 14, line 8 - page 15, line 21 * * page 18, line 5 - page 19, line 27 * * page 23, line 6 - page 25, line 9 *	10	H04L29/06 H04L12/56 H04Q7/22
A	US 5 369 501 A (AVERBUCH NIMROD ET AL) 29 November 1994 (1994-11-29) * column 2, line 14 - column 5, line 45 *	1-5,8	
A	EP 0 663 785 A (NOKIA MOBILE PHONES LTD) 19 July 1995 (1995-07-19) * page 3, line 24 - page 4, line 16 * * page 5, line 5 - page 7, line 23 *	1-5,8	
A	US 5 208 811 A (KASHIO JIRO ET AL) 4 May 1993 (1993-05-04) * column 6, line 7 - line 28 * * column 7, line 9 - column 8, line 57 *	1-5	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

H04L
H04Q

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	21 February 2000	Pham, P

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
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P : intermediate document

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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

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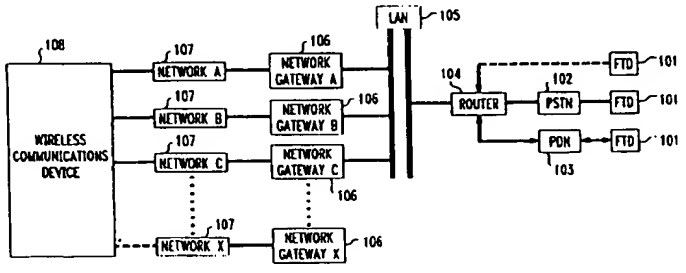
(54) Protocol converter and router for multi-mode wireless data communications

(57) The present invention encompasses an apparatus and method for supporting multiple wireless data communication networks between a wireless communications device and a fixed communications device or another wireless communications device. Two network elements compose the physical apparatus, a protocol converter and a router. Upon receiving packet data from a fixed communications device, a router will locate a destination wireless communications device. The router will then convert the packet data to a format usable by the wireless data network that the wireless communications device is currently using for wireless access. After conversion, the router will perform actual transmission of the packet data to the correct destination wireless network. Once the converted packet data is received by the wireless network base station, it will be transmitted via RF to the destination wireless communications device. The router will also perform reverse functions of receiving packet data from a wireless communications device across wireless data network and then perform necessary conversion to a format usable by fixed communications device. The router will then perform actual transmission of the converted packet data to the fixed communications device.

FIG. 1



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The present invention facilitates communication over a plurality of different wireless data networks by performing necessary protocol conversion of data messages out-bound from a wireless communications device to a format usable by an air-interface protocol of a selected wireless data network; performing necessary protocol conversion of data messages in-bound to the wireless communications device from the selected wireless data network to a format usable by the end-processor of the mobile-end device; and performing routing of data messages to the end-processor if in-bound messages are being received, or to the network RF modem for radio transmission to the selected wireless data network if out-bound messages are being transmitted.

The overall system architecture for facilitating wireless data communications across multiple networks is shown in Fig. 1. At the fixed network side, a fixed communications device (FTD) 101 is wired to a router 104. As would be understood, a plurality of wired connection options exist for connecting the fixed communications device with the router. Fig. 1 shows an example of using a Public Switched Telephone Network (PSTN) connection with an Integrated Services Digital Network (ISDN) interface. The wired connection between both the PSTN 102 and the fixed communications device 101 and the router 104 and PSTN 102 comprises an ISDN basic rate interface line (B-channel) whose operation and structure is well known to those skilled in the art and, therefore, the operation and structure thereof need not be described in detail. A fixed communications device comprises any communications device that is not mobile.

At the wireless network side a wireless communications device 108 is capable of transmitting across several networks A, B, C to X (107) usable by the wireless communications device 108. The networks 107 are coupled to associated network gateways A, B, C to X (106) which convert the wirelessly transmitted information from device 108 to protocols used by the local area network 105 (LAN). The LAN 105 is interconnected to the wired network including the fixed communications device 101.

The router architecture 200 as shown in FIG. 2 comprises two sub-routers, a master 202 and a slave 201, which both perform the dual function of converting and routing data messages across multiple wireless data networks. The sub-routers 201 and 202 are coupled to the fixed communications network shown as a PSTN 204 and coupled to the local area network 210 which is interconnected to the network gateways 205, 206. The network gateways 205, 206 convert information from the protocols used by the fixed network, such as the PSTN, to protocols used by the wireless networks 203, 207, 208 which carry wireless transmissions to and from the wireless communications device. The router is shown with a basic rate interface 209 to the PSTN network side. Data messages in-bound from a wireless communications device across the multiple wireless data networks will be converted by the router from the wireless data network protocol, if necessary, to the wireless data network protocol usable by a fixed communications device. After conversion, the router will route the data message to the network address of the fixed communications device.

A data message out-bound from the fixed communications device across multiple wireless data networks will be converted (if necessary) by the router from the network protocol used by the network containing the fixed communications device to the wireless data network protocol usable by the destination wireless communications device. After conversion, the router will route the data message through a network gateway 205,206 to the network address of a destination wireless communications device. The router further includes a maintenance subsystem 212 for performing fault recovery, redundancy, traffic measurement, and diagnostics. If any system fault occurs within one of the sub-routers, traffic can be automatically diverted to the other sub-router. A current routing table 214 is maintained and routinely updated when the network address changes for any message received from the network 203, 207, 208.

Once it is determined which network 203, 207, 208 a data message came from, the routing table 214 is updated. Any new message sent to the network is routed using the correct message format and to the correct address by retrieving the receiver's location from the routing table. A mobile database 216 is maintained for every active wireless communications device by storing a user profile for every active mobile user. Every message received by the router 200 is monitored (through user data received) to determine if it is the correct message type and any invalid message types are discarded. All messages received by the router are authenticated by monitoring a user identification (ID) and a source network address in the data message. Once received by the appropriate destination network control center (not shown), the data message will be routed through a destination network to a destination base station where the wireless communications device is currently being provided wireless access and/or registered. At the base station, the data message is transmitted via radio frequency (RF) transmission to a wireless communication device and received by the protocol converter of the wireless communications device in accordance with the present invention.

The internal system architecture of the protocol converter 300 associated with a wireless device is shown in FIG. 3. The functional blocks of the protocol converter 300 include timing and control (T&C) 301, end processor interface (EPI) 302, configuration and control (C&C) 303, and inter network control (INC) 304, the implementation of which functions would be understood by a person skilled in the art. Internal ports A, B, and C (305) provide interface connections to network radio frequency modems (NRFM) A, B, and C (306). The protocol converter includes a corresponding number of ports for X number of NRFMs 307. The EPI provides interface

scribed here by using a fixed-to-moving end description, it is clear that it is not limited in scope to wireless communications between a moving end user and a fixed communications device, but can also be applied to communications between two or more moving end users.

Numerous modifications and alternative embodiments of the invention will be apparent to those skilled in the art in view of the foregoing description. Accordingly, this description is to be construed as illustrative only and is for the purpose of teaching those skilled in the art the best mode of carrying out the invention. Details of the structure may be varied substantially without departing from the spirit of the invention and the exclusive use of all modifications which come within the scope of the appended claim is reserved.

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Claims

1. A method for enabling end-to-end wireless data communications across a plurality of wireless data networks between at least one wireless communications device and at least one second communications device, said method comprising the steps of:

   converting out-bound data messages from said wireless communications device by means of a protocol converter to a network protocol of one of said plurality of wireless data networks presently used by said wireless communications device for transmitting to said second communications device;
   transmitting from said protocol converter said out-bound data messages from said wireless communications device to said one of said plurality of wireless networks presently used by said wireless communications device;
   converting in-bound data messages to said wireless communications device by means of said protocol converter to said network protocol presently used by said wireless communications device; and
   transmitting said in-bound data messages from said protocol converter to said wireless communications device, and wherein said wireless communications device includes an end processor adapted to utilize the network protocol used by said wireless communications device and being adapted to couple to said protocol converter, said protocol converter further being coupled to a plurality of network radio frequency modems; further including the step of:
   transmitting from said plurality of network radio frequency modems said out-bound data messages from said wireless communications device and receiving said in-bound data messages from one of said plurality of wireless data networks.

2. The method according to claim 1, further including the steps of:

   converting out-bound data messages from said second communications device by means of a router to a network protocol presently used by said wireless communications device for receiving wireless communications;
   transmitting said out-bound data messages from said second communications device from said router to said one of said plurality of wireless data networks presently used by said wireless communications device;
   converting in-bound data messages to said second communications device by means of a router to a network protocol presently used by said second communications device; and
   transmitting said in-bound data messages from said router to said second communications device, wherein said step of transmitting said out-bound data messages from said second communications device from said router includes the step of transmitting said out-bound data messages to a network control center of said one of said plurality of wireless data networks presently used by said wireless communications device, and transmitting said out-bound data messages from said second communications device to said wireless communications device.

3. The method according to claim 2, further including performing at said router the steps of:

   extracting user data from a network data message frame of said in-bound data messages to said second communications device, the extracted user data being placed into a network frame of converted user data used by said second communications device,
   transmitting the converted user data to said second communications device;
   extracting user data from a network data message frame of said out-bound data messages from said second communications device, the extracted user data being placed into a network

data. and the network protocol of said second communications device is said automatic train control system.

FIG. 2

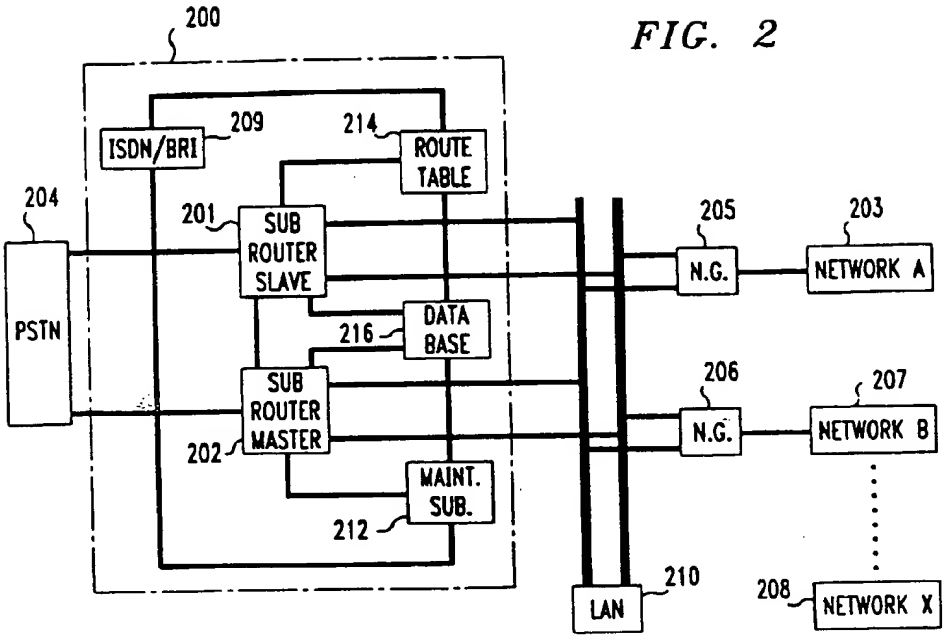

FIG. 3

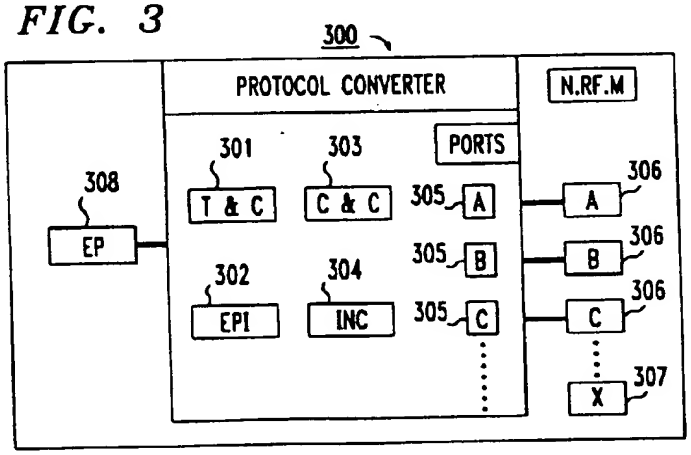

FIG. 4